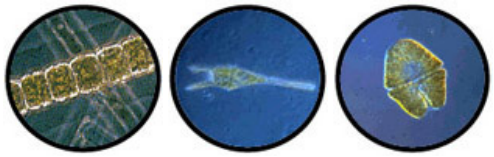
What are Phytoplankton?

by David Herring

Phytoplankton are microscopic plant-like organisms that live in the ocean. There are many species of phytoplankton, each of which has a characteristic shape. Phytoplankton grow abundantly in oceans around the world, and they are the foundation of the marine food chain. Small fish, and some species of whales, eat them as food. Larger fish then eat the smaller fish. Humans catch and eat many of these larger fish. Since phytoplankton depend upon certain conditions for growth, they are a good indicator of change in their environment. For these reasons, and because they also exert a global-scale influence on climate, phytoplankton are of primary interest to oceanographers and Earth scientists around the world.

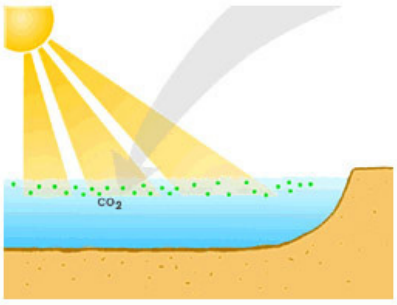
"Phytoplankton are the foundation of the marine food chain and they can influence Earth's climate."



Different species of phytoplankton come in many different shapes and sizes. But they all get their green color from chlorophyll, the pigment they use during photosynthesis. (Left photo courtesy of the SeaWiFS Project. Center and right photos courtesy of D.W. Coats.)

The life and death of phytoplankton

Like plants on land, phytoplankton require sunlight, water, and nutrients for growth. Because sunlight is most abundant at and near the sea surface, phytoplankton remain at or near the surface. Also like terrestrial plants, phytoplankton contain the pigment chlorophyll, which gives them their greenish color. Chlorophyll is used by plants for photosynthesis, in which sunlight is used as an energy source to fuse water molecules and carbon dioxide into carbohydrates—plant food. Phytoplankton (and land plants) use carbohydrates as "building blocks" to grow; fish and humans consume plants to get these same carbohydrates.



The cartoon animation to the left shows how phytoplankton use sunlight and carbon dioxide to make food and grow. When they die, their microscopic bodies settle to the bottom, thus storing vast amounts of carbon there over geological time. (Courtesy of Barbara Summey, Goddard SVS) (2.1MB)

The atmosphere is a rich source of carbon dioxide, as millions of tons of this gas dissolve into the ocean every year. However, phytoplankton still require other nutrients, such as iron, to survive. When surface waters are cold, the water column is unstable, and water from lower depths can well up to the surface. Upwelling water brings essential nutrients toward the surface where the phytoplankton can use them. However, when surface waters are warm (as during an El Niño), the water column is more stable; it is harder for colder, deeper currents to well up to the surface.The flow of life-sustaining nutrients slows.

As phytoplankton starve, so too do the fish and mammals that depend upon them for food. Even in ideal conditions, an individual phytoplankton only lives for about a day or two. When it dies, it sinks to the bottom. Consequently, over geological time, the ocean has become the primary storage sink for atmospheric carbon dioxide. About 90 percent of the world's total carbon content has settled to the bottom of the ocean, primarily in the form of dead biomass.

next: How do phytoplankton influence global change?

How do phytoplankton influence global change?

As previously stated, phytoplankton use carbon dioxide for photosynthesis. The larger the world's phytoplankton population, the more carbon dioxide gets pulled from the atmosphere, hence, the lower the average temperature due to lower volumes of this greenhouse gas. Scientists have found that a given population of phytoplankton can double its numbers on the order of once per day. In other words, phytoplankton respond very rapidly to changes in their environment. Large populations of this organism, sustained over long periods of time, could significantly lower atmospheric carbon dioxide levels and, in turn, lower average temperatures.

"PHYTOPLANKTON RESPOND VERY RAPIDLY TO CHANGES IN THEIR ENVIRONMENT"

Phytoplankton as indicators of change

As described above, phytoplankton depend upon sunlight, water, and nutrients to survive. Physical or chemical variance in any of these ingredients over time for a given region will affect the phytoplankton concentrations there. Populations of this marine plant will grow or diminish rapidly in response to changes in its environment. Changes in the trends for a given phytoplankton population—such as its density, areal distribution, and rate of population growth or diminishment—will alert Earth scientists that environmental conditions are changing there. Then, by comparing these phytoplankton trends to other measurements—such as temperature—scientists can learn more about how phytoplankton may be contributing to, and affected by, climatic and environmental change.

To human eyes, the ocean appears as shades of blue; sometimes blue-green. From outer space, satellite sensors can distinguish even slight variations in color to which our eyes are not sensitive. Different shades of ocean color reveals the presence of differing concentrations of sediments, organic materials, or even phytoplankton—all of which can be measured by satellites.

Due to their pigment—chlorophyll—phytoplankton preferentially absorb the red and blue portions of the light spectrum (for photosynthesis) and reflect green light. So, the ocean over regions with high concentrations of phytoplankton will appear as certain shades, from blue-green to green, depending upon the type and density of the phytoplankton population there.

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- What are phytoplankton?
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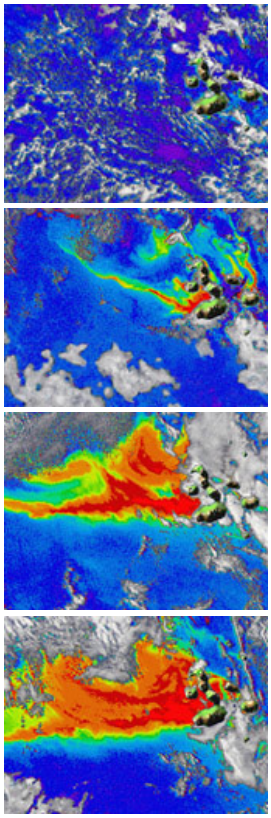
- What is a coccolithophore?

Relevant Satellite Missions:
- SeaWiFS
- Terra



This sequence of SeaWiFS ocean color imagery shows the impact of the recent El Niño on the productivity of phytoplankton around the Galapagos Islands in the Pacific Ocean. The top left image was taken during the height of the 1997-98 El Niño, while the bottom right image was taken during the more recent La Niña. Note the gradually flourishing bloom of phytoplankton as the surface waters cool, allowing the deeper, more nutrient-rich waters to upwell. (Courtesy of the SeaWiFS Project)

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